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AUTHOR Carangelo, Pasquale R.; Janeczek, Anthony J.
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ABSTRACT

Materials are provided for a two-semester digital and microprocessor technician postgraduate program. Prerequisites stated for the program include a background in DC and AC theory, solid state devices, basic circuit fundamentals, and basic math. A chronology of major topics and a listing of course objectives appear first. Theory outlines for each semester are followed by listings of experiments for the first and second semesters. Supplementary experiments are also provided. Major topics include a review of DC theory, AC theory, solid state devices, and basic circuit fundamentals; digital electronics; computer literacy; computer programming/flowcharting in high-level language; microprocessors; and microcomputers. Other contents include a list of digital and microprocessor systems compatible with the course (teaching systems, trainers, exercises, texts, manuals) and listings of references for each semester. (YLB)

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MICROPROCESSING COMPUTER TECHNICIAN

DIGITAL AND MICROPROCESSOR

TECHNICIAN PROGRAM

POST-GRADUATE 5th YEAR

DIVISION OF VOCATIONAL-TECHNICAL SCHOOLS

PREPARED FOR

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DIGITAL AND MICROPROCESSOR TECHNICIAN PROGRAM

Post-Graduate 5th Year

Submitted by:

Pasquale R. Carangelo
and
Anthony J. Janeczek

DIGITAL AND MICROPROCESSOR TECHNICIAN

Post-Graduate Program

PREREQUISITE PREREQUISITE PREREQUISITE

Student must have a background in D.C. Theory, A.C. Theory, solid state devices, basic circuit fundamentals and basic math.

CHRONOLOGY OF MAJOR TOPICS

1. Review D.C. Theory, A.C. Theory, solid state devices and basic circuit fundamentals.
2. Digital Electronics.
3. Computer Literacy and programming/flow charting in high-level language.
4. Microprocessors and Microcomputers

COURSE OBJECTIVES

The student will be able to:

1. Convert between the binary and decimal number systems and recognize the most commonly used binary codes.
2. Name the major components used in implementing digital circuits and explain how they operate.
3. Explain the operation of Digital logic gates.
4. Use Boolean Algebra to express logic operations.
5. Explain the operation of Flip Flops.
6. Discuss the operation and application of binary and BCD counters, shift registers, and other sequential logic circuits.
7. Name the most frequently used combinational logic circuits and explain their operation.
8. Explain how a digital computer is organized and how it operates.
9. Explain the operation and interrelation of microprocessors and system elements.
10. Demonstrate troubleshooting techniques for logic circuits and microprocessors.

DIGITAL AND MICROPROCESSOR TECHNICIAN

First Semester

THEORY OUTLINE

I. Introduction of Digital Electronics

A. Digital Techniques

1. Where are Digital circuits used?
2. Why use Digital circuits?

B. Binary Number System

1. Counting in Decimal and Binary
2. Place value
3. Binary to Decimal conversion
4. Decimal to Binary conversion

C. Binary Codes

1. The 8421 code
2. Excess 3 code
3. Gray code
4. Ascii code

D. Data Representation

1. Electromechanical devices
2. Logic levels
3. Positive and negative logic
4. Parallel vs. serial transmission

E. Logic Symbols

1. MIL STD 806
2. IEEE/IEE

II. Semiconductor Devices for Digital Circuits

A. Review of Semiconductors

II. A. 1. Bipolar transistor operations

2. Unipolar transistor characteristics

3. N channel and P channel Mosfets

III. Digital Logic Circuits

A. Types of Logic Circuits

1. And gate

2. Or gate

3. Inverter

4. Nand/Nor gates

5. Exclusive Or gate

6. Exclusive Nor gate

IV. Digital Integrated Circuits

A. Logic Circuit Characteristics

1. Logic levels

2. Propagation Delay

3. Power Dissipation

4. Fan in Fan out

B. Integrated Circuits

1. To 5

2. Flat Pack

3. Dip

4. Transistor Logic

5. Low power TTL

6. High power TTL

7. Schottgy TTL

8. Tri-state Logic Circuits

9. Emitter coupled Logic

10. Positive vs Negative buses

V. Boolean Algebra

A. Constructing Circuits from Boolean Expressions

1. Boolean rules
2. Truth Tables
3. Karnaugh Maps

VI. Flip-Flop and Registers

A. Memory Elements

1. The Reset-Set Flip Flop
2. The clocked Reset-Set Flip Flop
3. The Data Flip Flop
4. The J-K Flip Flops
5. Edge and level Triggered Flip-Flops
6. Comparison of Flip-Flops
7. Inversion Circles
8. Monostable Multivibrators

VII. Sequential Logic Circuits

A. Counters

1. The ripple counter
2. Modulo - 10 ripple counter
3. Synchronous Counters
4. Up counters Down counters
5. Frequency Dividers
6. Self-stopping counters
7. Digital waveforms for a Decade counter

B. Shift Registers

1. Shift Register applications
2. Shift Register Memory
3. Dynamic Shift Registers
4. Static Shift Registers
5. Serial Load Shift Registers
6. Parallel Load Shift Register
7. Universal Shift Register

VIII. Combination Logic Circuits

A. Decoders

1. BCD to Decimal decoder
2. Octal and Hex decoder
3. BCD to 7 Segment decoder

B. Encoders

1. 10 line to 4 line encoders

C. Multiplexers

1. Multiplexer Applications
2. Parallel to Serial Conversion

D. Demultiplexers

E. Random-Access Memories

1. An IC RAM
2. Using a RAM
3. Magnetic Core Memory
4. Bubble Memory
5. Computer Bulk Storage Devices

F. Read-only Memory

1. Using a ROM

2. Prom

3. EPROM, EEPROM, EAPROM

IX. Digital Design

A. Design Criteria

1. Maximum Performance

B. Combinational Logic Circuit Design

1. Truth Table Development

C. Sequential Logic Circuit Design

1. Design examples

2. Design variations

3. MOS handling procedures

4. Multilayer PC Boards

5. Wire wrapping

6. Manufacturer's Catalog and Specifications

X Digital Applications

A. Digital Test Equipment

1. The Frequence Counter

2. Digital Voltmeters

3. Dual-Trace Delayed sweep oscilloscopes

4. Logic Probes, Logic Pulsers ad Logic Clips (Monitors)

5. Logic Analyzers

6. Signature Analyzers

B. Digital Computers

1. Minicomputers

2. Microcomputers

3. Microprocessors

C. Digital Computer Organization

1. Memory
2. Control Unit
3. Arithmetic-logic unit
4. Input-output unit

D. Digital Computer Operation

1. Programming
2. Writing programs
3. Software

E. Microprocessors

1. Types of Microprocessors
2. Applications of Microprocessors
3. Differences between Microprocessors (i.e, 6800, 68000, 6502, 8080, 8085, F80)

DIGITAL AND MICROPROCESSOR TECHNICIAN

Second Semester

THEORY OUTLINE

I. A. What is a Microprocessor? - Review

B. What is a Microcomputer? - Review

C. Comparing different Microprocessors. - Review

II. Number Systems and Codes

A. Decimal Number System

B. Binary Number System

C. Binary to Decimal Conversions

D. Octal Number System

E. Binary to Octal Conversions

F. Hexadecimal Number System

G. Binary to Hexadecimal Conversions

H. Binary Codes

1. Binary Coded Decimals

2. Special Binary Codes

3. Alpha Numeric Codes

III. Microcomputer Basics

A. Terms and Procedures

B. Program Concept

C. Word Length

D. Hardware, Software, Firmware

E. Microprocessor (MPU)

F. Microprogramming - using microinstructions

G. Simulation of microprocessors

H. Memory

I. Program - Fetch and Execute

J. Fetch, Execute, Halt Instructions

K. Addressing Modes

L. Programs in Addressing

IV. Computer Arithmetic
Binary Arithmetic

A. Addition

B. Subtraction

C. Multiplication

D. Division

E. Negative Numbers

F. Two's Complement Arithmetic

G. Ten's Complement Arithmetic

H. Two's Supplement Substraction

I. Signed Numbers

J. Boolean Math

K. And

L. Or

M. Exclusive Or

N. Inversion

V. Programming

A. Flowcharts

B. Branching

C. Forward

D. Backward

E. Conditional Branching

V. F. Step by Step Procedure (Algorithms)

G. Multiplying

H. Dividing

I. BCD to Binary Conversion

J. Binary to BCD Conversion

K. Addition

L. Add with Carry (ADC)

M. Substract with Carry (SBC)

N. Arithmetic Shift Accumulator Left (ASLA)

O. Decimal Adjust Accumulator (DAA)

VI. The Microprocessor

A. Computer Literacy - A Hands-On Approach

B. Operating Systems - MDOS, CP/M, MP/M, MPL, PL/M, RSTS, RT-11, UNIX

C. Flow Charting and High-Level Languages - BASIC or PASCAL

VII. The Microprocessor

A. Architecture of the 6800 MPU (6820, etc.)

B. Programming Microprocessor

C. Block Diagram

D. Addressing Modes

E. Arithmetic

F. Data Handling

G. Logic

H. Data Test

I. Index Register

J. Stack Pointer

K. Branch Instructions

L. Condition Code Register

M. New Addressing Modes

N. Stack Operations - Cascade and Memory

O. Subroutines

1. Jump (JMP)

2. Branch to SUB (BSR)

3. Return from (RTS)

P. Input - Output Operations (I/O)

Q. Interrupts

VIII. A. Interfacing Fundamentals

B. Interfacing with Random Access Memory (RAM)

C. Interfacing with Display

D. Interfacing Requirements - RS232, IEEE488, (GPIB), Modems Optoisolators

E. Keyboard

F. Peripheral Interface Adapter (PIA)

G. I/O

H. PIA Register

I. Seven Segment Displays

J. Decoding Keyboards

K. Decoding a Switch Matrix

L. Digital to - Analog Conversion

M. Analog-to-Digital Conversion

N. Sample and Hold

O. Voltage to - Frequency and Frequency to Voltage converters

DIGITAL AND MICROPROCESSOR TECHNICIAN

First Semester

EXPERIMENTS

I. Binary Number System

A. Counting in Decimal and Binary

B. Binary to Decimal Conversion

C. Octal and Hexadecimal Number Systems

II. Review of Semiconductors

A. Bipolar transistor operations

B. Unipolar transistor characteristics

III. Types of Logic Circuits

IV. Boolean Algebra

V. Memory Elements

A. The Reset-Set Flip Flop

B. The clocked Reset-Set Flip Flop

C. The Data Flip Flop

D. The J-K Flip Flops

E. Monostable Multivibrators

VI. Counters

A. The ripple counter

B. Modulo - 10 ripple counter

C. Up counter Down counters

D. Self-stopping counters

E. Ring counters

VII. Shift Registers

A. Shift Register applications

B. Serial Load Shift Registers

VIII. Decoders

A. BCD to Decimal Decoder

IX. Encoders

X. Random-Access Memories

XI. Read-only Memory

XII. Digital Test Equipment

A. The Frequence Counter

B. Digital Voltmeters

C. Dual-Trace Delayed- Sweep Oscilloscope

D. Logic Probes, Logic Pulsers, and Logic Clips (Monitor)

E. Logic Analyzers

F. Signature Analyzers

XIII. Digital Computer Operation

A. Programming

XIV. Microprocessors

A. Types of Microprocessors

DIGITAL AND MICROPROCESSOR TECHNICIAN

Second Semester

EXPERIMENTS

I. Computer Literacy and Programming/Flow Charting

A. Computer Literacy - A Hands-On Approach

1. Programming in BASIC
2. Programming in LEVEL II
3. Programming in PASCAL
4. Programming in FORTRAN
5. Programming in COBOL

B. Operating Systems - MDOS, CP/M, MP/M, MPL, PL/M, RSTS, RT-11, UNIX

C. Flow Charting and High-Level Languages or BASIC or PASCAL

II. Number Systems and Codes

A. Binary to Decimal Conversions

B. Hexadecimal Number System

III. Microcomputer Basics

A. Program Concept

B. Program - Fetch and Execute

C. Fetch, Execute, Halt Instructions

D. Addressing Modes

E. Programs in Addressing

IV. Computer Arithmetic
Binary Arithmetic

A. Two's Complement Arithmetic

B. Two's Supplement Subtraction

C. And

D. Or

IV. Computer Arithmetic
Binary Arithmetic

E. Exclusive Or

F. Inversion

V. Programming

A. Branching

B. Conditional Branching

C. Add with Carry (ADC)

D. Subtract with Carry (SBC)

E. Arithmetic Shift Accumulator Left (ASLA)

F. Decimal Adjust Accumulator (DAA)

VI. The Microprocessor

A. Addressing Modes

B. Index Register

C. New Addressing Modes

D. Stack Operations - Cascade and Memory

E. Subroutines - Jump (JMP), Branch to SUB (BSR), Return from Sub. (RTS)

F. Input - Ouput Operations (I/O)

G. Interrupts

VII. Interfacing

A. Interfacing with Random Access Memory (RAM)

B. Interfacing with Display

C. Peripheral Interface Adapter (PIA)

D. I/O

E. Seven Segment Displays

F. Decoding Keyboards

G. Decoding a Switch Matrix

DIGITAL AND MICROPROCESSOR TECHNICIAN

SUPPLEMENTARY EXPERIMENTS ONLY

I. Number Systems and Codes - Using Microprocessor Trainer - Binary and Decimal Experiments - Hexadecimal and Decimal Experiments

II. Straight Line Programs

III. Arithmetic and Logic Experiments

IV. Program Experiments

V. Additional Instructions for Program

VI. Interfacing Experiments

- A. Memory
- B. Clock
- C. Address Decoding
- D. Data Output
- E. Data Input
- F. Introduction to the Peripheral Interface Adapter (PIA)
- G. Audio Output
- H. Key Matrix and Parallel to Serial Conversion
- I. Digital to Analog and Analog to Digital Conversion

VII. Diagnostic and Fault Analysis/Correction

VIII. PC Board Repair Procedures

DIGITAL AND MICROPROCESSOR SYSTEMS

COMPATIBLE WITH COURSE

COMMERCIAL TEACHING SYSTEMS

Heathkit - ET 3400 Trainer

Heathkit - Model EE-3401 Textbook and Experiments

HICKOK TEACHING SYSTEMS

K-6800 - Trainer

7-251 - Text - Digital Logic Fundamentals

7-290 - Text - Fundamentals of Memory Interface

7-288 - Text - A Study of MC6800 Based Systems

7-294 - Text - Introduction to Microprocesssors/Microcomputer

7-289 - Text - Systems

7-289 - Text - Digital Logic and Computer Fundamentals

TETRA SYSTEMS CORPORATIONS

Tetra S-7400-System Digital Logic Trainer

Tetra 8010 - Microcomputer Trainer

Model 7400-2-Manuals - Digital Electronic Exercises

Model 8010 - Micro Trainer Exercises

Model 8092A - Microprocessing System Exercises

DIGIAC

CT-80 Microcomputer System - Text - Manuals

CT-80 Central Processing Unit - Text - Manuals

CT-81 Fault Insertion Terminal - Text - Manuals

CT-10 Computer Training System - Text - Manuals

DYNALOGIC

DES-921 Digital Electronic Trainer - Text - Manuals

MAS-900P Microprocessor Trainer - Text Manuals

REFERENCES

First Semester

TITLE	AUTHOR	DATE	PUBLISHER
Digital Electronics	Tokheim	1979	McGraw-Hill
Digital Computer Fundamentals 5th edition	Bartee	1981	McGraw-Hill 1977
Bugbook I & II	Larsen & Rony	1977	E & L Instruments
Digital Techniques	Heathkit Learning Publications	1979	Heath Company
Digital Principles and Applications	Malvino/Leach	1981	McGraw-Hill
Digital Computer Electronics	Malvino	1977	McGraw-Hill
Digital Logic Circuits	Sol Libes	1978	Hayden Book Company
Digital Logic Fundamentals	Floyd	?	Merrill Publishing Co.
Digital Systems Principles and Applications	Ronald Tocci	1977	Prentice Hall
Fundamentals of Digital Electronics	Rutkowski & Olesky	1979	Prentice Hall
TTL Cookbook	Don Lancaster	1974	Howard W. Sams

REFERENCES

Second Semester

TITLE	AUTHOR	DATE	PUBLISHER
Computer Literacy A Hands-On Approach	Luehrmann & Peckham	1982	McGraw-Hill Inc.
Introduction to Micro processors	Charles M. Gilmore	1981	McGraw-Hill Inc. ISBNO-07-013301-2
Microprocessors	Heathkit	3rd ed. 1980	Heathkit Learning Publications EB-6401
Digital Techniques	Heathkit	1980	Heathkit Leaning Pub.
Solid State Electronics	George B. Rutkowski	2nd ed. 1981	Bobbs-Merrill 97315
Effectively Using The Oscilloscope	Robert G. Middleton	1961	Howard W. Sams 21794
Programming in FORTRAN	Heathkit	1981	Heathkit Education Syst.
Electricity Principles and Applications	Richard J. Fowler	1979	McGraw-Hill Inc. 0-07-021704-X
Electronics Principles and Applications	Charles A. Schuler	1979	McGraw-Hill Inc. 0-07-055619-9
Digital Technology	Gerald E. Williams	2nd ed. 1982	Science Research Assoc. ISBN-0-574-21555-7
Microprocessor/Microcomputer	Fredrick E. Driscoll	1983	Brenton Publishers ISBNO-534-01326-0

SOFTWARE CATALOG

Quality Educational Microcomputer Software	Apple, Pet, TRS-80	1982-1983	Charles Clark Company 168 Express Drive, South Brentwood, New York 117

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